

## **On the occurrence of phreatic eruptions at Ruapehu: statistics and probabilistic hazard forecast for ballistics**

Although phreatic eruptions pose a serious threat to people in crater proximity (as it has been recently demonstrated at Ontake and Etna volcanoes), they are often underestimated and have been comparatively understudied. The detailed eruption catalogue for Ruapehu Volcano in New Zealand provides an exceptional opportunity to study the statistics of the occurrence of phreatic explosions at a crater lake volcano.

In this view, we first performed a statistical analysis on this database, which suggests that phreatic events at Ruapehu tend to cluster in time. We argue that this may be linked to an increase in the heat flow during periods of a more shallow-seated magma column. According to Ruapehu's eruption catalogue, the average monthly probability for a phreatic explosion to occur is about 10%. However, the frequency of phreatic explosions is significantly higher than the background level in the years preceding magmatic eruptions.

Secondly, we combined the output of 60,000 clast-ejection simulations with a Bayesian event tree tool (PyBetVH), in order to perform a probabilistic assessment of the hazard due to ballistic ejecta in the summit area of Ruapehu, which is frequently visited by hikers and skiers. The resulting hazard assessment shows that the probability for the summit to be affected by a ballistic impact density potentially lethal to people within the next month is up to 6%. The hazard is especially high on the northern lakeshore, where the only mountain refuge is located.

We believe that our results contribute to quantify the local hazard due to ballistics, as well as to increase the general perception of hazards due to steam-driven explosions.